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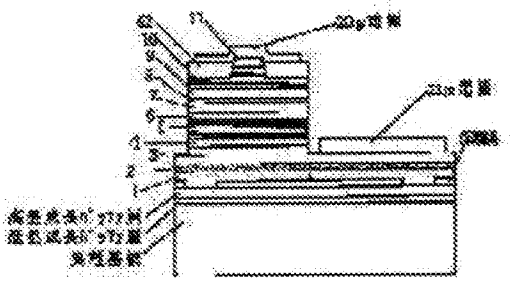
(54) NITRIDE SEMICONDUCTOR LASER ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a nitride semiconductor laser element that turns into an improved single mode, where no ripples are mixed onto FFP of a main laser beam.
SOLUTION: A nitride semiconductor laser element is provided with an n-type contact layer 3 and an active layer 7 in multiple quantum well structure with a well layer that is made of InaGa1-aN (0<a<1), and a barrier layer that is made of InbGa1-bN (0≤b<1) between an n-type clad layer 5 that is made of a multilayer film layer with a nitride semiconductor containing Al and a p-type clad layer 10, that is made of a multilayer film layer with a nitride semiconductor containing Al on a substrate 1. Also, the laser element is provided with a light-absorbing layer 2, containing at least one layer of a first nitride semiconductor that is made of undoped IndGa1-dN (0<d<1), with a smaller band gap energy than that of the well layer between the n-type contact layer 3 and the substrate 1.



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CLAIMS

[Claim(s)]
[Claim 1]Between p type clad layers which consist of a n type contact layer, and a n type clad layer which consists of a multilayer film layer which has a nitride semiconductor containing aluminum and a multilayer film layer which has a nitride semiconductor containing aluminum at least on a substrate, It has an active layer of multiple quantum well structure which has a barrier layer which consists of a well layer which consists of $In_aGa_{1-a}N$ (0< a<1), and $In_bGa_{1-b}N$ (0<=b<1), Between said n type contact layer and a substrate, A nitride semiconductor laser element having a light absorption layer containing at least one or more layers of the 1st nitride semiconductor that consists of undoped $In_dGa_{1-d}N$ (0< d<1) in which bandgap energy is smaller than a

well layer.
[Claim 2]The 1st nitride semiconductor with which said light absorption layer consists of undoped $In_dGa_{1-d}N$ (0< d<1) in which bandgap energy is smaller than a well layer, The nitride semiconductor laser element according to claim 1 consisting of a multilayer film which laminates at least one or more layers of the 2nd nitride semiconductor that consists of undoped GaN, respectively.
[Claim 3]The nitride semiconductor laser element according to claim 1 or 2, wherein thickness of said light absorption layer is 0.02-1 micrometer.
[Claim 4]The nitride semiconductor laser element according to any one of claims 1 to 3, wherein thickness of the 1st nitride semiconductor layer that constitutes a light absorption film of said multilayer film is 0.01-0.05 micrometer and thickness of the 2nd nitride semiconductor layer is 0.01-0.5 micrometer.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the nitride semiconductor laser element from which especially a far field pattern becomes good about the laser device which consists of nitride semiconductors ($In_xaluminum_yGa_{1-x-y}N$, 0<=x, 0<=y, x+y<=1).
[0002]
[Description of the Prior Art]This invention persons have proposed element structure as a usable nitride semiconductor laser element, for example in the literature of Jpn.J.Appl.Phys.Vol.37(1998)pp.L309-L312, Part2, No.3B, and 15 March 1998. The art of the above-mentioned literature on the nitride semiconductor substrate which consists of GaN with few rearrangements by which selective growth was carried out via the SiO_2 film selectively formed in the silicon-on-sapphire upper part, considering it as the element which carries out the plural laminates of the nitride semiconductor layer used as laser device structure — the continuous oscillation in a room temperature — 10,000 hours or more are made possible. The n type contact layer which comes from n-$aluminum_kGa_{1-k}N$ (0<=k<1) as element structure on the nitride semiconductor substrate by which selective growth was carried out, The n type clad layer which consists of a multilayer film of the crack prevention layer which consists of $In_{0.1}Ga_{0.9}N$, and n-$aluminum_{0.14}Ga_{0.86}N$/GaN, The n type guide layer which consists of n-GaN, the active layer of the multiple quantum well structure which consists of $In_{0.02}Ga_{0.98}N/In_{0.15}Ga_{0.85}N$. It is constituted by the p type clad layer which consists of a multilayer film of the p type electronic confining layer which consists of p-$aluminum_{0.2}Ga_{0.8}N$, the p type guide layer which consists of p-GaN, and p-$aluminum_{0.14}Ga_{0.86}N$/GaN, and the p type contact layer which consists of p-GaN.
[0003]n in this and a p type clad layer are considering it as a multilayer film (superstructure), even if they raise the composition ratio of aluminum, by the ability to prevent generating of a crack, are made lower [sufficient grade to shut up light] than the refractive index of a laser waveguide, and have an operation of good optical confinement. improvement in the life characteristic according that slight optical closing depth comes out enough to the fall of a threshold — in addition, a far field pattern (it may be called the following FFP.) serves as a single mode.
[0004]
[Problem(s) to be Solved by the Invention]However, in order to raise the fitness to the application to various products of the above-mentioned laser device, When FFP of the main laser beam was examined still in detail, the

taper emitted to the main laser beam of a single mode from the end face of a n type contact layer (a nitride semiconductor substrate is included) lapped, and it was checked that the main laser beam serves as a small multi-mode. When coming to form p electrode and n electrode in the same side side as this cause, The inside of the n type contact layer which the light which emitted light by the active layer leaks from a n type clad layer, and shows a larger value than refractive indicees, such as a support pair on a broth, a n type clad layer, and the rear face of a nitride semiconductor substrate, is guided, Since the taper emitted from the n type contact layer end face laps with the main laser beam emitted from a resonance surface, a ripple rides on a main laser beam and FFP is considered to be a small multi-mode. When it is considered as a laser device, without removing silicon on sapphire, since the refractive index of sapphire is small, such a problem is produced similarly. When the product using a laser device is put in practical use, in order to operate a laser beam good, it is desirable to control that a ripple rides on FFP. Then, the purpose of this invention is to provide FFP of a main laser beam with the nitride semiconductor laser element used as the good single mode on which a ripple does not ride.

[0005]

[Means for Solving the Problem]That is, this invention can attain the purpose of this invention by composition of following the (1) - (4).

(1) Between p type clad layers which consist of a n type contact layer, and a n type clad layer which consists of a multilayer film layer which has a nitride semiconductor containing aluminum and a multilayer film layer which has a nitride semiconductor containing aluminum at least on a substrate, It has an active layer of multiple quantum well structure which has a barrier layer which consists of a well layer which consists of $In_aGa_{1-a}N$ ($0<a<1$), and $In_bGa_{1-b}N$ ($0<=b<1$), Between said n type contact layer and a substrate, A nitride semiconductor laser element having a light absorption layer containing at least one or more layers of the 1st nitride semiconductor that consists of undoped $In_dGa_{1-d}N$ ($0<d<1$) in which bandgap energy is smaller than a well layer.

(2) The 1st nitride semiconductor with which said light absorption layer consists of undoped $In_dGa_{1-d}N$ ($0<d<1$) in which bandgap energy is smaller than a well layer, A nitride semiconductor laser element given in the above (1) consisting of a multilayer film which laminates at least one or more layers of the 2nd nitride semiconductor that consists of undoped GaN, respectively.

(3) A nitride semiconductor laser element the above (1), wherein thickness of said light absorption layer is 0.02-1 micrometer, or given in (2).

(4) said -- a multilayer film -- a light absorption film -- constituting -- the -- one -- a nitride semiconductor layer -- thickness -- 0.01 - 0.05 -- micrometer -- it is -- the -- two -- a nitride semiconductor layer -- thickness -- 0.01 - 0.5 -- micrometer -- it is -- things -- the feature -- carrying out -- the above -- (-- one --) - (-- three --) -- either -- a statement -- a nitride semiconductor laser element .

[0006]That is, in order that this invention may prevent disorder of FFP by light which began to leak from a n type clad layer, FFP is made good by forming a light absorption layer containing undoped InGaN in which bandgap energy is smaller than a well layer of an active layer between a n type contact layer and a substrate.

[0007]Conventionally, this invention persons are indicating a LED element which forms in JP,8-130327,A a layer (for example, InGaN) in which bandgap energy is smaller than a nitride semiconductor layer which constitutes a luminous layer between a substrate and a n type contact layer. In this art, a layer in which bandgap energy is smaller than a luminous layer passes main light emission by an impurity level of Zn or Si, absorbs only light by luminescence between bands of InGaN, narrows half breadth of a main-light-emission spectrum by an impurity level, and makes color purity good.

[0008]On the other hand, a undoped light absorption layer in this invention, Light which began to leak from a n type clad layer provided as an optical confinement layer is absorbed altogether substantially, discharge of light from the n type contact layer end face is controlled, and FFP of a main laser beam emitted from a laser waveguide is made into a good single mode. Therefore, this invention solves a newly produced problem, when a good laser device was realized to a usable grade.

[0009]In this invention, a reason for making a light absorption layer undoped, It is because it is possible that a ripple which intensity of photoluminescence becomes strong and rides on FFP becomes large if there is a tendency which luminescence produces slightly and is emitted from the end face inside a light absorption layer and an impurity is doped, after absorbing light which began to leak from a n type clad layer. If it is undoped like this invention, since it is weak compared with an impurity dope layer, even if light is emitted from the end face of a light absorption layer, intensity of photoluminescence becomes a weak thing about noise, and can weaken influence on FFP. If a light absorption layer is made undoped, a light absorption layer of InGaN can be formed with sufficient crystallinity, and crystallinity formed on this, such as a n type contact layer and an active layer, can also be made good. If a good crystalline element is obtained, a life characteristic will improve.

[0010]This invention forms a light absorption layer between a n type contact layer and a substrate in

consideration of forming a light absorption layer in a position which does not participate in an electric flow, in order to avoid a rise of forward voltage (Vf) by rise of a bulk resistor, since a light absorption layer is made undoped as mentioned above.

[0011]As mentioned above, this invention can solve the conventional problem by making undoped a light absorption layer smaller than bandgap energy of a well layer of an active layer, and forming in a specific position of element structure.

[0012]By considering it as a multilayer film which contains the 1st nitride semiconductor that consists a light absorption layer of InGaN(s), and the 2nd nitride semiconductor that consists of GaN(s) in this invention, Without reducing the crystallinity of a light absorption layer, although light which began to leak from a n type clad layer is made into sufficient grade to absorb all substantially at a thick film, it is desirable. In this invention, thickness of a light absorption layer is preferred, although light which began to leak that it is 0.02-1 micrometer from a n type clad layer is absorbed good. Thickness of the 1st nitride semiconductor that consists of InGaN(s) in this invention when a light absorption layer comprises a multilayer film, It is 0.01-0.05 micrometer, and thickness of the 2nd nitride semiconductor that consists of GaN(s) is preferred, although a light absorption layer of a multilayer film is formed with sufficient crystallinity as it is 0.01-0.5 micrometer. In the case of a multilayer film containing the 1st and 2nd nitride semiconductors, within thickness of above-mentioned each class, a light absorption layer adjusts the number of times of lamination, etc., and forms a light absorption layer so that it may become the thickness of the above-mentioned light absorption layer.

[0013]

[Embodiment of the Invention]At least the nitride semiconductor laser element of this invention on a substrate A n type contact layer, And between the p type clad layers which consist of a n type clad layer which consists of a multilayer film layer which has a nitride semiconductor containing aluminum, and a multilayer film layer which has a nitride semiconductor containing aluminum, It has an active layer of multiple quantum well structure which has a barrier layer which consists of a well layer which consists of $In_aGa_{1-a}N$ ($0< a<1$), and $In_bGa_{1-b}N$ ($0<=b<1$), It has a light absorption layer containing at least one or more layers of the 1st nitride semiconductor that consists of undoped $In_dGa_{1-d}N$ ($0< d<1$) in which bandgap energy is smaller than a well layer between said n type contact layer and a substrate.

[0014]In this invention, as long as the position which a light absorption layer makes form is formed between a n type contact layer and a substrate, it may be formed in any. Since there is nothing with weak intensity of photoluminescence that is made to increase resistance of an element also as undoped when a light absorption layer is formed in such a position, crystallinity can be made good by not causing the rise of Vf and also supposing that it is undoped. What is necessary is just to include at least one layer of the 1st nitride semiconductor that consists of undoped $In_dGa_{1-d}N$ as a light absorption layer in which bandgap energy is smaller than the well layer which consists of $In_aGa_{1-a}N$ of an active layer in this invention, The monolayer which consists of the 1st nitride semiconductor, or the multilayer film which laminates the 1st nitride semiconductor and the other nitride semiconductor is mentioned. It is a multilayer film which laminates the 1st nitride semiconductor that consists of undoped $In_dGa_{1-d}N$ ($0< d<1$) preferably as a light absorption layer, and at least one or more layers of the 2nd nitride semiconductor that consists of undoped GaN, respectively. When the light absorption layer comprises a multilayer film, without spoiling the crystallinity of the 1st nitride semiconductor containing In, a light absorption layer can be used as a thick film, and it is desirable. When the 2nd nitride semiconductor that consists of GaN(s) is used as a layer of others which constitute a multilayer film, the crystallinity of the 1st nitride semiconductor and the crystallinity of a light absorption layer can be made good, and it is desirable.

[0015]The value of d of the 1st nitride semiconductor that consists of $In_dGa_{1-d}N$ ($0< d<1$), It is suitably adjusted by the wavelength of the light of In of a well layer which emits light by a jam and an active layer comparatively, and the composition ratio of In is adjusted so that the light which begins to leak from a n type clad layer can be absorbed good and it may become smaller than the bandgap energy of a well layer. When the light absorption layer has the 1st nitride semiconductor that consists of $In_dGa_{1-d}N$ at least, it is desirable although the light which emits light from the active layer containing InGaN, and begins to leak from a n type clad layer is absorbed. The value of d is similarly adjusted, when a light absorption layer consists only of the 1st nitride semiconductor, or when it is a multilayer film which laminates the 1st nitride semiconductor and 2nd nitride semiconductor.

[0016]0.02-1 micrometer of the total thickness of light absorption layers in case a light absorption layer consists of a monolayer of the 1st nitride semiconductor is 0.1-0.3 micrometer preferably. Light can be absorbed good also as a monolayer as it is this range, and a light absorption layer can be formed with still more sufficient crystallinity. The thickness of the monolayer of the 1st nitride semiconductor in case a light absorption layer is a

multilayer film. While the light which emits light by an active layer 0.01-0.05 micrometer as it is 0.05-0.1 micrometer preferably and is this range, and began to leak from a n type clad layer is absorbable good, the crystallinity of a monolayer is preferred at a good point. On the other hand, 0.01-0.5 micrometer, it is 0.05-0.3 micrometer, and the thickness of the monolayer of the 2nd nitride semiconductor has good crystallinity in it being this range, and is preferably preferred at the point which can also make the crystallinity of the whole light absorption layer good. The number of times of lamination in particular of the 1st nitride semiconductor and the 2nd nitride semiconductor is not limited, but single thickness laminates the 1st and 2nd nitride semiconductors of a mentioned range within the thickness of the above-mentioned light absorption layer. For example, since there is a tendency that it is hard to maintain the crystallinity of InGaN when the composition ratio of In is large, it is preferred to carry out thin [of the thickness of the monolayer of the 1st nitride semiconductor] in this case, and to increase the number of times of lamination, although a good crystalline light absorption film is obtained.

[0017]As mentioned above, the light which the light absorption layer in this invention emits light by the active layer of a laser device, and began to leak from a n type clad layer, Prevent guiding waves by a n type contact layer, and disturbing FFP, and this invention from this point, The problem produced when the material used as the substrate of a laser device has the material of a value with a small refractive index and comprises a n type contact layer, or when a nitride semiconductor is used as a substrate and the support pair etc. are in contact with this substrate rear is solved. It is a thing of the material as a substrate in this invention whose refractive index is smaller than a n type contact layer. For example, it becomes nitride semiconductors known conventionally, such as sapphire which makes the principal surface either C side, R side and A side, an insulating substrate like a spinel ($MgA1_2O_4$), and an oxide substrate which carries out lattice matching to a nitride semiconductor, and a substrate material with a small refractive index can be used. These substrate materials can be used also as a different-species board used with the below-mentioned selective growth. In this invention, it is good also considering the material which has as a substrate the above-mentioned substrate material and a nitride semiconductor with few rearrangements which carried out selective growth on this using growth of the transverse direction of a nitride semiconductor as a substrate.

[0018]What is necessary is just the method that it is not limited but the rearrangement of a nitride semiconductor can be reduced especially as the method of the selective growth of a nitride semiconductor. For example, the method of a statement, etc. can be mentioned in each specification of Japanese Patent Application No. No. 77245 [ten to], Japanese Patent Application No. No. 275826 [ten to], and Japanese Patent Application No. No. 363520 [ten to] which the method of a statement and these people submitted to said J.J.A.P.

[0019]The n type clad layer which consists of a multilayer film layer which has a nitride semiconductor containing aluminum in this invention, The p type clad layer which consists of a multilayer film layer which has a nitride semiconductor containing aluminum, The active layer of multiple quantum well structure which has a barrier layer which consists of a well layer which consists of $In_aGa_{1-a}N$ ($0< a<1$), and $In_bGa_{1-b}N$ ($0<=b<1$), and a n type contact layer in particular are not limited.

[0020]It explains below, using drawing 1 as a desirable embodiment. Drawing 1 is a typical sectional view showing the nitride semiconductor laser element which is the 1 embodiment of this invention. On the nitride semiconductor substrate 1 which carried out selective growth to drawing 1 on different-species boards, such as sapphire, The light absorption layer 2 and n type impurity (for example, Si) containing at least one layer of the 1st nitride semiconductor that consists of undoped $In_dGa_{1-d}N$ are doped. Becoming $aluminum_aGa_{1-a}N$. The n type contact layer 3 which consists of ($0< a<1$), the crack prevention layer 4 which consists of $In_gGa_{1-g}N$ ($0.05<=g<=0.2$) of a Si dope, and $aluminum_eGa_{1-e}N$ ($0.12<=e<0.15$). The n type clad layer 5 of the included multilayer film, the n type guide layer 6 which consists of undoped GaN, the active layer 7 of the multiple quantum well structure which consists of $In_bGa_{1-b}N$ ($0<=b<1$), $aluminum_dGa_{1-d}N$ of a Mg dope. The p type electronic confining layer 8 of at least one or more layers which consists of ($0< d<=1$), The stripe of the ridge shape which consists of the p type guide layer 9 which consists of undoped GaN, the p type clad layer 10 of the multilayer film containing $aluminum_fGa_{1-f}N$ ($0< f<=1$), and the p type contact layer 11 which consists of GaN of a Mg dope. The nitride semiconductor laser element which it has is shown. p electrode is formed in the top layer of the stripe of ridge shape, and n electrode is formed on a n type contact layer. It explains still in detail about each class below.

[0021]As selective growth which can be used in this invention, growth of the lengthwise direction of a nitride semiconductor will not be limited, especially if it is a growing method which can control a rearrangement selectively at least using growth of temporary ****** and a transverse direction. For example, whether a nitride

semiconductor grows on the different-species board which consists of a different material from a nitride semiconductor concretely or by forming selectively the protective film which consists of material which cannot grow easily, and growing up a nitride semiconductor from on the. A nitride semiconductor grows from the portion in which the protective film is not formed, and the nitride semiconductor of a thick film is obtained by growing up to be a transverse direction toward a protective film top by continuing growth.

[0022]It will not be limited especially if it is a substrate which consists of a different material from a nitride semiconductor as a different-species board, For example, different substrate materials from nitride semiconductors known conventionally, such as sapphire which makes the principal surface C side shown in drawing 2, R side, and A side, an insulating substrate like a spinel ($MgAl_2O_4$), and an oxide substrate which carries out lattice matching to a nitride semiconductor, can be used. In the above, as a desirable different-species board, it is sapphire and is C side of sapphire still more preferably. The off-angle of the C side of sapphire is carried out to step form from a point of being able to prevent generating of a detailed crack inside the nitride semiconductor produced by carrying out selective growth, and the thing of the range whose off-angle angles theta (theta shown in drawing 3) are 0.1 degree - 0.3 degree is preferred. If the characteristic of a laser device is easily stabilized as the off-angle angle theta is less than 0.1 degree, and the inside of the nitride semiconductor of selective growth has a tendency a detailed crack becomes easy to generate and an OFF angle exceeds 0.3 degree on the other hand, The surface state of the nitride semiconductor of selective growth becomes step form, if element structure is grown up on it, a step will be emphasized a little, and there is a tendency to become easy to cause a short circuit and a threshold rise of an element. the above -- it producing, in order that a different-species board and a nitride semiconductor may not carry out lattice matching, and a detailed crack, If a n type contact layer etc. are formed in the case where it produces in process of either of the selective growth of a nitride semiconductor, and the nitride semiconductor substrate by which the rearrangement was reduced, it may generate in a n type contact layer. Such a detailed crack may become a cause which causes the fall of a life characteristic. Therefore, it is preferred to use the substrate by which the off-angle was carried out as mentioned above at the point of preventing generating of a detailed crack.

[0023]On different-species boards, such as sapphire by which the off-angle was carried out to the above step form, a protective film is formed, once it grows up [directly or] a nitride semiconductor. or [that a nitride semiconductor does not grow up to be a protective film surface as a protective film] -- or it not being limited especially if it is the material which has the character to be hard to grow up, but. For example, silicon oxide (SiO_X), silicon nitride (Si_XN_Y), The metal etc. which have the melting point of not less than 1200 ** besides oxides, such as titanium oxide (TiO_X) and zirconium oxide (ZrO_X), nitrides, and these multilayer films can be used. SiO_2 and SiN are mentioned as a desirable protective coat material. In order to form a protective coat material in the surfaces, such as a nitride semiconductor, gaseous phase film production art, such as vacuum evaporation, weld slag, and CVD, can be used, for example. In order to form selectively (alternative), the protective film which has predetermined shape can be formed by producing the photo mask which has predetermined shape using photolithography technology, and carrying out gaseous phase film production of said material via the photo mask. Although not limited, especially the shape of a protective film can be formed, for example in the shape of a dot, a stripe, and go board surface state, and it is formed so that a stripe may become vertical to an orientation flat side (A side of sapphire) in the shape of stripe shape preferably. The surface area in which the protective film is formed can obtain the nitride semiconductor substrate in which the larger one than the surface area of the portion in which the protective film is not formed prevents a rearrangement, and has good crystallinity.

[0024]The relation between the stripe width of a protective film in case a protective film is stripe shape, and the width of the portion (window part) in which the protective film is not formed is 16-18:3 preferably 10:3 or more. If the stripe width of a protective film and the width of a window part have the above-mentioned relation, a nitride semiconductor becomes easy to cover a good protective film, and a rearrangement can be prevented good. As stripe width of a protective film, it is 11-24 micrometers preferably, and 2-5-micrometer 6-27 micrometers are 2-4 micrometers preferably as width of a window part, for example. When element structure is formed on the nitride semiconductor produced by carrying out selective growth and the stripe of ridge shape is formed in the top layer of a p type nitride semiconductor layer, It is preferred for being able to reduce a threshold and raising the reliability of an element that the stripe of ridge shape is the protective film upper part, and avoids the center section of a protective film, and is formed. It is because it is good compared with the crystallinity of the window part upper part, so the crystallinity of the nitride semiconductor of the protective film upper part is preferred for reducing a threshold as for this. If the adjoining nitride semiconductors grown-up from the window part are the portions joined with lateral growth, they may produce an opening in such a joint part and the stripe of ridge shape is formed in the upper part of this opening, near the center of a protective film, It is because it is easy to

spread a rearrangement from an opening working [a laser device], so there is a tendency for the reliability of an element to deteriorate.

[0025]Although a protective film may be directly formed in a different-species board, and making the buffer layer of low-temperature growth form, and also having grown up the nitride semiconductor of high temperature growth, and also making it form prevents a rearrangement, it is preferred. For example, it is not less than 200 ** in 900 ** or less temperature, and either AlN, GaN, AlGaN InGaN, etc. are made to come to grow up by a thickness number (10 A - hundreds of A) as a buffer layer of low-temperature growth. This buffer layer is preferred, although the grating constant injustice of a different-species board and the nitride semiconductor layer of high temperature growth is eased and generating of a rearrangement is prevented. As a nitride semiconductor of high temperature growth, undoped GaN, GaN which doped the n type impurity, and GaN which doped Si can be used, and it is desirable undoped GaN. 900 ** - 1100 ** of these nitride semiconductors grow up to be an elevated temperature and a concrete target on a buffer layer at 1050 ** preferably. Although thickness in particular is not limited, 1-20 micrometers is 2-10 micrometers preferably, for example.

[0026]Next, the protective film was formed, and also selective growth of the nitride semiconductor is carried out, and the nitride semiconductor substrate 1 is obtained. In this case, GaN which doped undoped GaN or impurity (for example, Si, germanium, Sn, Be, Zn, Mn, Cr, and Mg) as a nitride semiconductor to grow up is mentioned. As growing temperature, 900 ** - 1100 ** are more specifically grown up at the temperature near 1050 **, for example. When the impurity is doped, it is desirable although a rearrangement is controlled. The growth after making it grow up by MOCVD (organometal chemistry vapor phase growth) etc. which are easy to control a growth rate and covering the protective film with the nitride semiconductor of selective growth the first stage grown up on a protective film may be grown up by HVPE (halide vapor phase growth) etc.

[0027]Next, the nitride semiconductor (it has different-species boards, such as sapphire) produced by carrying out selective growth is used as a substrate, and the light absorption layer 2 is grown up on this. The light absorption layer which contains the 1st nitride semiconductor that consists of undoped $In_dGa_{1-d}N$ ($0< d<1$) in which bandgap energy is smaller than a well layer as the light absorption layer 2 as described above, Or the light absorption layer which consists of a multilayer film which laminates the 1st nitride semiconductor and at least one or more layers of the 2nd nitride semiconductor that consists of undoped GaN, respectively can be formed. The details of the light absorption layer 2 are as having described above.

[0028]Next, the n type contact layer 3 is grown up on the light absorption layer 2. As a n type contact layer, $aluminum_aGa_{1-a}N$ ($0<=a<1$) which had the n type impurity (preferably Si) doped is grown up, and a grows up $aluminum_aGa_{1-a}N$ of 0.01-0.05 preferably. If a n type contact layer is formed with the 3 yuan mix crystal containing aluminum, even if the detailed crack has occurred in the nitride semiconductor substrate 1, Propagation of a detailed crack can be prevented, and also generating of the detailed crack to the n type contact layer by difference of the grating constant of the nitride semiconductor substrate 1, and the light absorption layer 2 and a n type contact layer and a coefficient of thermal expansion, etc. can be prevented, and it is desirable. As doped quantity of a n type impurity, they are $1x10^{18}/cm^3$ - $5x10^{18}/cm^3$. n electrode is formed in this n type contact layer 3. As thickness of the n type contact layer 3, it is 1-10 micrometers. It is desirable for crystallinity becoming good, if undoped $aluminum_aGa_{1-a}N$ ($0< a<1$) may be grown up and this undoped layer is grown up between the light absorption layer 2 and the n type contact layer 3, and raising a life characteristic. The thickness of a undoped n type contact layer is several micrometers.

[0029]Next, the crack prevention layer 4 is grown up on the n type contact layer 3. As the crack prevention layer 4, $In_gGa_{1-g}N$ ($0.05<=g<=0.2$) of a Si dope is grown up, and g grows up $In_gGa_{1-g}N$ of 0.05-0.08 preferably. Although it is omissible, this crack prevention layer 4 is preferred although generating of the crack in an element is prevented, when the crack prevention layer 4 is formed on the n type contact layer 3. As doped quantity of Si, they are $5x10^{18}/cm^3$. When growing up the crack prevention layer 4 and the mixed crystal ratio of In is enlarged ($x>=0.1$), the crack prevention layer 4 can absorb the light which emits light from the active layer 7 and began to leak from the n type clad layer 5, can prevent disorder of the far field pattern of a laser beam, and is preferred. As crack prevention layer 4 thickness, it is the thickness of the grade which does not spoil crystallinity, for example, is specifically 0.05-0.3 micrometer.

[0030]Next, the n type clad layer 5 is grown up on the crack prevention layer 4. It is formed as a layer of the multilayer film which has a nitriding semiconductor containing $aluminum_eGa_{1-e}N$ ($0.12<=e<0.15$) as the n type clad layer 5. A multilayer film is shown and the multilayer film structure which laminated the nitride semiconductor layer from which a presentation differs mutually For example, an $aluminum_eGa_{1-e}N$ ($0.12<=e<0.15$) layer, It laminates combining the layer which consists of the nitride semiconductor with which this

aluminum$_e$Ga$_{1-e}$N differs from a presentation, for example, the thing from which the mixed crystal ratio of aluminum differs, a thing of a 3 yuan mix crystal containing In, or GaN. When it is a multilayer film which laminates aluminum$_e$Ga$_{1-e}$N and GaN as a desirable combination in this, a good crystalline nitride semiconductor layer can be laminated at the same temperature, and it is desirable. a more desirable multilayer film --- carrying out --- undoped aluminum$_e$Ga$_{1-e}$N and GaN of a n type impurity (for example, Si) dope are laminated --- it combines and comes out. A n type impurity may be doped by aluminum$_e$Ga$_{1-e}$N. The doped quantity of a n type impurity is $4x10^{18}/cm^3$ - $5x10^{18}/cm^3$. If the n type impurity is doped in this range, resistivity can be made low and crystallinity will not be spoiled. The thickness of a monolayer is preferred 100 A or less, and such a multilayer film laminates 70 A or less of nitride semiconductor layers [40 A or less of] of thickness of 10 A or more preferably still more preferably. In spite of a n type clad layer's becoming that single thickness is 100 A or less with a superstructure and containing aluminum, generating of a crack can be prevented and crystallinity can be made good. As the total thickness of the n type clad layer 5, it is 0.7-2 micrometers. The average composition of aluminum of the whole n type clad layer is 0.05-0.1. It is the composition ratio of a grade which does not generate a crack as the average composition of aluminum is this range, and is composition ratio desirable although the difference of a refractive index with a laser waveguide is fully acquired.

[0031]Next, the n type guide layer 6 is grown up on the n type clad layer 5. The nitride semiconductor which consists of undoped GaN as the n type guide layer 6 is grown up. As thickness of the n type guide layer 6, a threshold falls that it is 0.1-0.07 micrometer, and it is desirable. By making the n type guide layer 6 undoped, the propagation loss in a laser waveguide decreases, a threshold becomes low, and it is desirable.

[0032]Next, the active layer 7 is grown up on the n type guide layer 6. As the active layer 7, it is the multiple quantum well structure containing In$_b$Ga$_{1-b}$N ($0<=b<1$). As a well layer of the active layer 7, b is In$_b$Ga$_{1-b}$N of 0.1-0.2 and b is In$_b$Ga$_{1-b}$N of 0-0.01 as a barrier layer. An impurity may be doped to both a well layer, and both [either or] which constitute the active layer 7. When a barrier layer is made to dope an impurity preferably, a threshold falls and it is desirable. As thickness of a well layer, it is 30-60 A and is 90-150 A as thickness of a barrier layer.

[0033]The multiple quantum well structure of the active layer 6 begins from a barrier layer, even if it begins from a barrier layer and finishes it as a well layer, even if it finishes it as a barrier layer, it begins from a well layer, even if it finishes it as a barrier layer, it may begin from a well layer and a well layer may finish it. It is desirable for beginning from a barrier layer preferably, and what repeats the pair of a well layer and a barrier layer 2 to 5 times, and the thing which repeats the pair of a well layer and a barrier layer 3 times preferably making a threshold low, and raising a life characteristic.

[0034]Next, the p type electronic confining layer 8 is grown up on the active layer 7. At least one or more layers which consist of aluminum$_d$Ga$_{1-d}$N ($0< d<=1$) of a Mg dope are made to come to grow up as the p type electronic confining layer 8. d is aluminum$_d$Ga$_{1-d}$N of the Mg dope of 0.1-0.5 preferably. 10-1000 A of thickness of the p type electronic confining layer 8 is 50-200 A preferably. The electron in the active layer 7 can be shut up good as thickness is a mentioned range, and a bulk resistor can also be suppressed low, and it is desirable. The doped quantity of Mg of the p type electronic confining layer 8 is $1x10^{19}/cm^3$ - $1x10^{21}/cm^3$. It adds to reducing a bulk resistor as doped quantity is this range, The after-mentioned can be undoped, Mg can be spread good to the p type guide layer to grow up, and the p type guide layer 9 which is a thin film layer can be made to contain Mg in the range of $1x10^{16}/cm^3$ - $1x10^{18}/cm^3$. When the p type electronic confining layer 8 is grown up at the temperature into which low temperature, for example, an about 850-950 ** active layer, is grown up, and the same temperature, it can prevent decomposition of an active layer and is preferred. The p type electronic confining layer 8 may comprise two-layer [of the layer of low-temperature growth, and the layer grown up at the temperature of about 100 ** from the growing temperature of an elevated temperature, for example, an active layer]. Thus, since the layer of low-temperature growth will prevent decomposition of an active layer and the layer of high temperature growth will reduce a bulk resistor if it comprises two-layer, it becomes good on the whole. As for 10-50 A and a high-temperature-growth layer, although the thickness in particular of each class in case the p type electronic confining layer 8 comprises two-layer is not limited, 50-150 A is [a low-temperature growth phase] preferred.

[0035]Next, the p type guide layer 9 is grown up on the p type electronic confining layer 8. It makes it come as a nitride semiconductor layer which consists of undoped GaN as the p type guide layer 9 to grow up. Thickness is 0.1-0.07 micrometer, and a threshold becomes it low that it is this range, and it is preferred. As described above, although the p type guide layer 9 is grown up as a undoped layer, Mg doped by the p type electronic confining

layer 8 diffuses it, and Mg contains it in the range of $1x10^{18}/cm^3$ - $1x10^{18}/cm^3$.
[0036]Next, the p type clad layer 10 is grown up into the p type guide layer 9. It is formed as a layer of the multilayer film which has a nitride semiconductor layer containing $aluminum_fGa_{1-f}N$ ($0<f<=1$) and a nitride semiconductor layer which contains $aluminum_fGa_{1-f}N$ ($0.05<=f<=0.15$) preferably as the p type clad layer 10. A multilayer film is the nitride semiconductor layer from which a presentation differs mutually the laminated multilayer film structure, and For example, an $aluminum_fGa_{1-f}N$ layer, It laminates combining the layer which consists of the nitride semiconductor with which $aluminum_fGa_{1-f}N$ differs from a presentation, for example, the thing from which the mixed crystal ratio of aluminum differs, a thing of a 3 yuan mix crystal containing In, or GaN. When it is a multilayer film which laminates $aluminum_fGa_{1-f}N$ and GaN as a desirable combination in this, a good crystalline nitride semiconductor layer can be laminated at the same temperature, and it is desirable. a more desirable multilayer film --- carrying out --- undoped $aluminum_fGa_{1-f}N$ and GaN of a p type impurity (for example, Mg) dope are laminated --- it combines and comes out. A p type impurity may be doped by $aluminum_fGa_{1-f}N$. The doped quantity of a p type impurity is $1x10^{17}/cm^3$ - $1x10^{19}/cm^3$. When the p type impurity is doped in this range, it is the doped quantity of the grade which does not spoil crystallinity, and a bulk resistor becomes low and is preferred. The thickness of a monolayer is preferred 100 A or less, and such a multilayer film laminates 70 A or less of nitride semiconductor layers [40 A or less of] of thickness of 10 A or more preferably still more preferably. In spite of a n type clad layer's becoming that single thickness is 100 A or less with a superstructure and containing aluminum, generating of a crack can be prevented and crystallinity can be made good. It is desirable in order to reduce forward voltage (Vf) as it is 0.4-0.5 micrometer and is this range as the total thickness of the p type clad layer 10. The average composition of aluminum of the whole p type clad layer is 0.05-0.1. This value is preferred, although generating of a crack is controlled and refractive index difference with a laser waveguide is acquired.
[0037]Next, the p type contact layer 11 is grown up on the p type clad layer 10. The nitride semiconductor layer which consists of GaN of a Mg dope is made to come to grow up as a p type contact layer. Thickness is 10-200 A. The doped quantity of Mg is $1x10^{19}/cm^3$ - $1x10^{22}/cm^3$. By adjusting the doped quantity of such thickness and Mg, the carrier concentration of the p type contact layer 11 rises, and it **-comes to be easy with ohmic ** of p ******.
[0038]In the element of this invention, the stripe of ridge shape is formed by being etched from a p type contact layer and etched to under surface (substrate side) than a p type contact layer. For example, the stripe etched from the p type contact layer 11 as shown in drawing 1 to the middle of the p type clad layer 10, or the stripe etched from the p type contact layer 11 to the n type contact layer 2 is mentioned.
[0039]As shown, for example in drawing 1, the insulator layer which has a value smaller than the refractive index of a laser waveguide area is formed in the flat surface of the nitride semiconductor layer which followed the side and its side of the stripe of the ridge shape etched and formed. As an insulator layer formed in the side of a stripe, etc., For example, the oxide which contains at least a kind of element chosen from the group which a refractive index becomes from Si, V, Zr, Nb, Hf, and Ta which have a value of the about 1.6 to 2.3 neighborhood, BN, AlN, etc. are mentioned, and they are any one or more sorts of elements of the oxide of Zr and Hf, and BN preferably. p electrode is formed in the surface of the p type contact layer 11 which is furthermore in the top layer of a stripe via this insulator layer. As width of the stripe of the ridge shape etched and formed, 0.5-4 micrometers is 1-3 micrometers preferably. Horizontal transverse mode turns into a single mode easily for the width of a stripe to be this range, and it is desirable. When etching is missing from the substrate side and is made rather than the interface of the p type clad layer 10 and a laser waveguide area, it is desirable although an aspect ratio is brought close to 1. As mentioned above, the etching quantity, the stripe width, **** and the laser beam by which the laser beam of a single mode will be obtained and for which an aspect ratio will be close brought further circularly if the refractive index of the insulator layer of the side of a stripe, etc. are specified further, and lens design of a stripe of ridge shape become easy, and are preferred. In the element of this invention, conventionally, p electrode, n electrode, etc. can choose publicly known various things suitably, and can use them.
[0040]
[Example]The example which is the 1 embodiment of this invention is shown below. However, this invention is not limited to this. Although this example shows MOVPE (metal-organic chemical vapor deposition). The method of this invention is not restricted to MOVPE method, and HVPE (halide vapor phase growth), MBE (molecular beam vapor phase growth), etc. can apply all the methods known although a nitride semiconductor is grown up, for example.

[0041][Example 1] The nitride semiconductor laser element which is the 1 embodiment of this invention shown in drawing 1 as Example 1 is manufactured.
[0042]C side by which the off-angle was carried out to step form as a different-species board as shown in drawing 3 is made into the principal surface, the off-angle angle of theta= 0.15 degree, the step level difference of about 20 A, and the terrace width W -- it is about 800 A, and a cage hula side is made into A side, and a step prepares silicon on sapphire vertical to A side. This silicon on sapphire shall be set in a reaction vessel, temperature shall be 510 **, hydrogen is used for carrier gas, ammonia and TMG (trimethylgallium) are used for material gas, and the buffer layer of the low-temperature growth which comes from GaN on silicon on sapphire is grown up by 200-A thickness. If only TMG is stopped after buffer layer growth, temperature is raised to 1050 ** and it becomes 1050 **, TMG, ammonia, and silane gas will be used for material gas, and the buffer layer of the high temperature growth which consists of undoped GaN will be grown up by 5-micrometer thickness. Next, the photo mask of stripe shape is formed on the wafer which laminated the buffer layer of high temperature growth, and the protective film which consists of SiO_2 the stripe width of 18 micrometers and 3 micrometers [of a window part] in width with a CVD system is formed by 0.1 micrometer of thickness. The stripe direction of a protective film is a vertical direction to a sapphire A side. A wafer is moved to a reaction vessel after protective film formation, and at 1050 **, TMG and ammonia are used for material gas, and the nitride semiconductor layer which consists of undoped GaN is grown up by 15-micrometer thickness, and let it be the nitride semiconductor substrate 1. Lamination growth of the following element structures is carried out by using the obtained nitride semiconductor as the nitride semiconductor substrate 1.
[0043](Light absorption layer 2) On the nitride semiconductor substrate 1, at 780 **, to material gas TMI (trimethylindium), The 1st nitride semiconductor that consists of undoped $In_{0.15}Ga_{0.85}N$ using TMG and ammonia gas is grown up by 500-A thickness, then TMI is stopped and 1000 A of the 2nd nitride semiconductor that consists of undoped GaN is grown up. And this operation is repeated 3 times, respectively, the 1st nitride semiconductor and 2nd nitride semiconductor are laminated, and the light absorption layer 2 which consists of a multilayer film of 4500 A of the total thickness is grown up.
[0044](Undoped n type contact layer) [It is not illustrated by drawing 1.]
The n type contact layer which uses TMA (trimethylaluminum), TMG, and ammonia gas for material gas at 1050 **, and comes from undoped $aluminum_{0.05}Ga_{0.95}N$ on the light absorption layer 2 is grown up by 1 micrometer of thickness.
TMA, TMG, and ammonia gas are used for material gas at the (n type contact layer 3), next the same temperature, Silane gas (SiH_4) is used for impurity gas, and the n type contact layer 3 which consists of $aluminum_{0.05}Ga_{0.95}N$ which cm^{-3}[$3x10^{18}$/]-doped Si is grown up by 3-micrometer thickness.
[0045]The (crack prevention layer 4), next temperature shall be 800 **, and to material gas TMG, Using TMI (trimethylindium) and ammonia, silane gas is used for impurity gas and the crack prevention layer 4 which consists of $In_{0.06}Ga_{0.92}N$ which cm^{-3}[$5x10^{18}$/]-doped Si is grown up by 0.15 micrometer of thickness.
[0046]The (n type clad layer 5), next temperature shall be 1050 **, and to material gas TMA, The A horizon which consists of undoped $aluminum_{0.14}Ga_{0.86}N$ is grown up by 25-A thickness using TMG and ammonia, Then, TMA is stopped and the B horizon which consists of GaN which cm^{-3}[$5x10^{18}$/]-doped Si is grown up by 25-A thickness, using silane gas as impurity gas. And this operation is repeated 160 times, respectively, an A horizon and a B horizon laminate, and the n type clad layer 5 which consists of a multilayer film (superstructure) of 8000 A of the total thickness is grown up.
[0047]TMG and ammonia are used for material gas at the (n type guide layer 6), next the same temperature, and the n type guide layer 6 which consists of undoped GaN is grown up by 0.075 micrometer of thickness.
[0048]The (active layer 7), next temperature shall be 800 **, and TMI, TMG, and ammonia are used for material gas, The barrier layer which consists of $In_{0.01}Ga_{0.99}N$ which cm^{-3}[$5x10^{18}$/]-doped Si is grown up by 100-A thickness, using silane gas as impurity gas. Then, silane gas is stopped and the well layer which consists of undoped $In_{0.11}Ga_{0.89}N$ is grown up by 50-A thickness. This operation is repeated 3 times and the active layer 7 of the multiple quantum well structure (MQW) of 550 A of the total thickness that finally laminated the barrier layer is grown up.
[0049]At the (p type electronic confining layer 8), next the same temperature, to material gas TMA, Cp_2Mg (magnesium cyclopentadienyl) is used as impurity gas using TMG and ammonia, The p type electronic confining layer 8 which consists of $aluminum_{0.4}Ga_{0.6}N$ which cm^{-3}[$1x10^{19}$/]-doped Mg is grown up by 100-A thickness.

[0050]The (p type guide layer 9), next temperature shall be 1050 **, TMG and ammonia are used for material gas, and the p type guide layer 9 which consists of undoped GaN is grown up by 0.075 micrometer of thickness. Although this p type guide layer 9 is grown up as undoped, by diffusion of Mg from the p type electronic confining layer 8, Mg concentration serves as $5x10^{16}/cm^3$, and it shows a p type.
[0051]TMA, TMG, and ammonia are used for material gas at the (p type clad layer 10), next the same temperature, The A horizon which consists of undoped $aluminum_{0.1}Ga_{0.9}N$ is grown up by 25-A thickness, Then, TMA is stopped and the B horizon which consists of GaN which cm^{-3}[$5x10^{18}$/]-doped Mg is grown up by 25-A thickness, using Cp_2Mg as impurity gas. And this operation is repeated 100 times, respectively, an A horizon and a B horizon laminate, and the p type clad layer 10 which consists of a multilayer film (superstructure) of 5000 A of the total thickness is grown up.
[0052]TMG and ammonia are used for material gas at the (p type contact layer 11), next the same temperature, The p type contact layer 11 which consists of GaN which cm^{-3}[$1x10^{20}$/]-doped Mg is grown up by 150-A thickness, using Cp_2Mg as impurity gas.
[0053]After ending reaction and in a reaction vessel, annealing is performed for a wafer at 700 ** among a nitrogen atmosphere, and a p type layer is low-resistance-ized further. Pick out a wafer from a reaction vessel after annealing, and the protective film which consists of SiO_2 is formed in the surface of p side contact layer of the top layer, It etches by $SiCl_4$ gas using RIE (reactive ion etching), and as shown in drawing 4, the surface of the n side contact layer 3 which should form n electrode is exposed. Next, as shown in drawing 4 (a), all over almost [of the p side contact layer 11 of the top layer] with a PVD device. After forming the 1st protective film 61 that consists of an Si oxide (mainly SiO_2) by 0.5 micrometer of thickness, on the 1st protective film 61, the mask of predetermined shape is covered and the 3rd protective film 63 that consists of photoresist is formed at the stripe width of 1.8 micrometers, and 1 micrometer in thickness. Next, as shown in drawing 4 (b), after the 3rd protective film 63 formation, with a RIE (reactive ion etching) device, said 1st protective film is etched by using the 3rd protective film 63 as a mask using CF_4 gas, and it is considered as stripe shape. By processing with an etching reagent after that and removing only photoresist, as shown in drawing 4 (c), the 1st protective film 61 with a stripe width of 1.8 micrometers can be formed on the p side contact layer 10.
[0054]As shown in drawing 4 (d), after the 1st protective film 61 formation of stripe shape, the p side contact layer 11 and the p side clad layer 10 are again etched using $SiCl_4$ gas by RIE, and the stripe of ridge shape with a stripe width of 1.8 micrometers is formed. However, the stripe of ridge shape is the upper part of the protective film formed when performing selective growth, as shown in drawing 1, and it is formed so that the center section of a protective film may be avoided. As a wafer is transported to a PVD device after ridge stripe formation and it is shown in drawing 4 (e), The 2nd protective film 62 that consists of a Zr oxide (mainly ZrO_2) is continued and formed by 0.5 micrometer of thickness on the p side clad layer 10 exposed by etching the 1st protective film 61 top. Thus, if Zr oxide is formed, in order to take the insulation of a p-n side, stability of horizontal microfiche can be aimed at and it is desirable. Next, a wafer is immersed in fluoric acid, and as shown in drawing 4 (f), the 1st protective film 61 is removed by the lift-off method.
[0055]Next, as shown in drawing 4 (g), the p electrode 20 which consists of nickel/Au is formed in the surface of the p side contact layer 11 which the 1st protective film 61 on the p side contact layer 11 was removed, and was exposed. However, as stripe width of 100 micrometers, the p electrode 20 is gone across and formed on the 2nd protective film 62, as shown in this figure. The n electrode 21 which consists of Ti/aluminum is formed in the surface of the n side contact layer 3 exposed as shown in drawing 1 in a direction parallel to a stripe after the 2nd protective film 62 formation.
[0056]After grinding the silicon on sapphire of the wafer which formed n electrode and p electrode as mentioned above and being referred to as 70 micrometers, in a direction vertical to the electrode of stripe shape, cleavage is carried out to bar shape from the substrate side, and a resonator is produced to a cleavage plane (the 11 to 00th page, the field =M side equivalent to the side of a hexagonal prism-like crystal). The dielectric multilayer which consists of SiO_2 and TiO_2 is formed in a resonator face, and it is considered as a laser device as cut a bar and finally shown in drawing 1 in a direction parallel to p electrode. As for cavity length, it is desirable to be referred to as 300-500 micrometers. The obtained laser device was installed in the heat sink, wire bonding of each electrode was carried out, and laser oscillation was tried at the room temperature. As a result, in a room temperature on threshold 2.5 kA/cm^2 and the threshold voltage 5V. Continuous oscillation with an oscillation wavelength of 400 nm is checked, and a room temperature shows the life of 10,000 hours or more, and also discharge of the light from the end face of a n type contact layer is controlled, and it becomes a good single

mode, without a ripple riding on FFP of the laser beam emitted from a resonance surface.
[0057][Example 2] In Example 1, the light absorption layer 2 is made to constitute from a monolayer as follows, and also a nitride semiconductor laser element is produced similarly.
(Light absorption layer 2) The 1st nitride semiconductor that uses TMI (trimethylindium), TMG, and ammonia gas for material gas at 780 **, and comes from undoped $In_{0.15}Ga_{0.85}N$ on the nitride semiconductor substrate 1 is grown up by 0.2 micrometer of thickness, and the light absorption layer 2 is grown up. The obtained laser devices are Example 1 and FFP good almost similarly, and have a good life characteristic.
[0058][Example 3] In Example 1, the p type electronic confining layer 8 is made to constitute from two-layer as follows, and also a nitride semiconductor laser element is produced similarly.
(P type electronic confining layer 8) Temperature shall be 800 ** and to material gas TMA, Cp_2Mg (magnesium cyclopentadienyl) is used as impurity gas using TMG and ammonia, The A horizon of the low-temperature growth which consists of $aluminum_{0.4}Ga_{0.6}N$ which cm^{-3}[$5x10^{18}$/]-doped Mg shall be grown up by 30-A thickness, and temperature shall be 900 ** continuously, The p type electronic confining layer 8 which consists of two-layer [of the A horizon of low-temperature growth and the B horizon of high temperature growth which consist of $aluminum_{0.4}Ga_{0.6}N$ which cm^{-3}/ $5x10^{18}$//-doped Mg, and to which the B horizon of high temperature growth is made to come to grow up by 70-A thickness] is grown up. The obtained laser device emits the laser beam of good FFP like Example 1, and is an element with a good life characteristic.
[0059][Example 4] In Example 1, when growing up the crack prevention layer 4, composition ratio of In is set to 0.2, The crack prevention layer 4 which consists of $In_{0.2}Ga_{0.8}N$ which cm^{-3}[$5x10^{18}$/]-doped Si is grown up by 0.15 micrometer of thickness, and also a laser device is produced similarly. The light which the obtained laser device has a good life characteristic like Example 1, and also emits light by the active layer 6, and began to leak from a n type clad layer is absorbed by the light absorption layer 2 and the clad prevention layer 4, and FFP becomes fitness from Example 1.
[0060][Example 5] In Example 1, the light absorption layer 2 is changed as follows, and also a laser device is produced similarly.
(Light absorption layer 2) On the nitride semiconductor substrate 1, at 780 **, to material gas TMI (trimethylindium), The 1st nitride semiconductor that consists of undoped $In_{0.15}Ga_{0.85}N$ using TMG and ammonia gas is grown up by 0.1 micrometer of thickness, then TMI is stopped and 0.3 micrometer of the 2nd nitride semiconductor that consists of undoped GaN is grown up. And this operation is repeated twice, respectively, the 1st nitride semiconductor and 2nd nitride semiconductor are laminated, and the light absorption layer 2 which consists of a multilayer film of 0.8 micrometer of the total thickness is grown up. A result with an obtained laser device as good almost similarly as Example 1 is obtained.
[0061][Example 6] In Example 1, the light absorption layer 2 is changed as follows, and also a laser device is produced similarly.
(Light absorption layer 2) On the nitride semiconductor substrate 1, at 780 **, to material gas TMI (trimethylindium), The 1st nitride semiconductor that consists of undoped $In_{0.15}Ga_{0.85}N$ using TMG and ammonia gas is grown up by 0.01 micrometer of thickness, then TMI is stopped and 0.02 micrometer of the 2nd nitride semiconductor that consists of undoped GaN is grown up. And this operation is repeated 5 times, respectively, the 1st nitride semiconductor and 2nd nitride semiconductor are laminated, and the light absorption layer 2 which consists of a multilayer film of 0.15 micrometer of the total thickness is grown up. A result with an obtained laser device as good almost similarly as Example 1 is obtained.
[0062][Example 7] In Example 2, the thickness of the light absorption layer 2 shall be 0.5 micrometer, and also a laser device is produced similarly. A result with an obtained laser device as good almost similarly as Example 2 is obtained.
[0063]
[Effect of the Invention]This invention can provide the nitride semiconductor laser element from which FFP of a laser beam serves as a good single mode without a ripple.

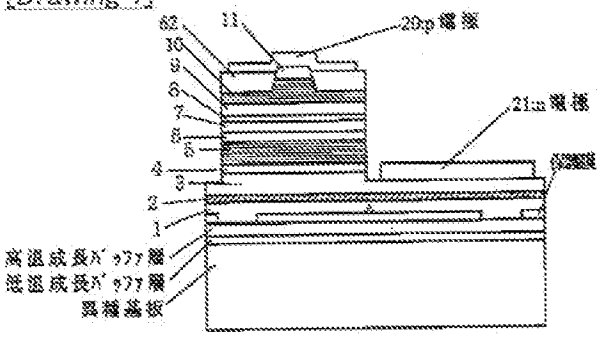
[Translation done.]

DESCRIPTION OF DRAWINGS

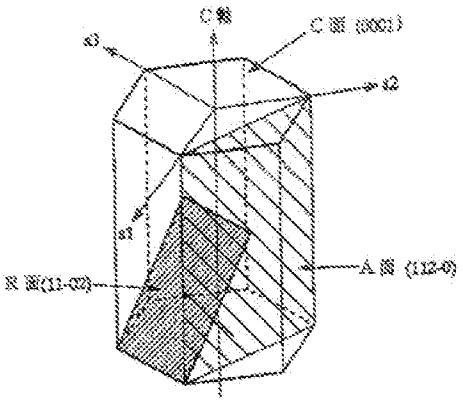
[Brief Description of the Drawings]
[Drawing 1]Drawing 1 is a typical sectional view showing the nitride semiconductor laser element which is the 1 embodiment of this invention.
[Drawing 2]Drawing 2 is an unit cell figure showing the plane direction of sapphire.
[Drawing 3]Drawing 3 is a typical sectional view showing the partial shape of the different-species board which carried out the off-angle.
[Drawing 4]Drawing 4 is a typical sectional view showing a partial structure of the wafer in each process of the method of being the 1 embodiment which forms the stripe of ridge shape.
[Description of Notations]
1 ... Nitride semiconductor substrate
2 ... Light absorption layer
3 ... N type contact layer
4 ... Crack prevention layer
5 ... N type clad layer
6 ... N type guide layer
7 ... Active layer
8 ... P type electronic confining layer
9 ... P type guide layer
10 ... P type clad layer
11 ... P type contact layer

DRAWINGS

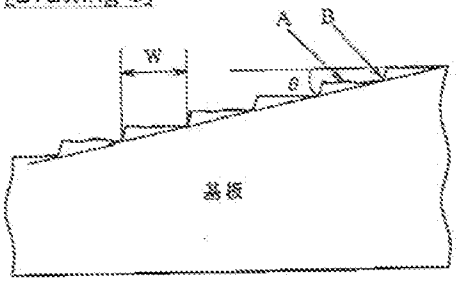
[Drawing 1]



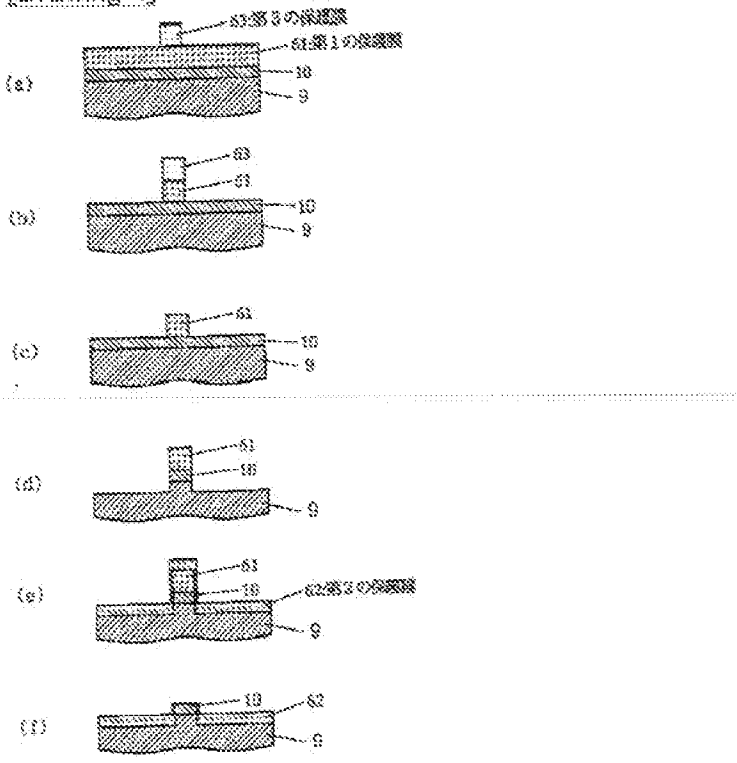
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]